UG1 LONGWALLS 101 TO 103
SUBSIDENCE MONITORING
PROGRAM

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1.0 INTRODUCTION

The Moolarben Coal Complex is an open cut and underground coal mining operation located approximately 40 kilometres (km) north of Mudgee in the Western Coalfield of New South Wales (NSW) (Figure 1).

Moolarben Coal Operations Pty Ltd (MCO) is the operator of the Moolarben Coal Complex on behalf of the Moolarben Joint Venture (Moolarben Coal Mines Pty Ltd [MCM], Sojitz Moolarben Resources Pty Ltd and a consortium of Korean power companies). MCO and MCM are wholly owned subsidiaries of Yancoal Australia Limited.

Stage 1 at the Moolarben Coal Complex has been operating for several years and at full development will comprise three open cut mines (OC1, OC2 and OC3), a longwall underground mine (UG4), and mining related infrastructure (including coal processing and transport facilities) (Figure 2).

Stage 2 at the Moolarben Coal Complex has commenced and at full development will comprise one open cut mine (OC4), two longwall underground mines (UG1 and UG2) and mining related infrastructure (Figure 2).

The UG1 Underground Mine is a component of the approved Moolarben Coal Complex (Figure 2). The UG1 Underground Mine commenced first workings in April 2016 and is commenced secondary workings (longwall extraction) in October 2017 by longwall mining methods from the Ulan Seam within Mining Lease (ML) 1605, ML 1606, ML 1628, ML 1691 and ML 1715 (Figure 3).

Mining operations at the Moolarben Coal Complex are currently approved until 31 December 2038 and would continue to be carried out in accordance with Project Approval (05_0117) (Moolarben Coal Project Stage 1) as modified and Project Approval (08_0135) (Moolarben Coal Project Stage 2) as modified, granted under the NSW Environmental Planning and Assessment Act, 1979 (EP&A Act).
Figure 2

Moolarben Coal Complex Layout

Source: MCO (2019); NSW Dept of Industry (2019)
1.1 PURPOSE AND SCOPE

This UG1 Longwalls 101 to 103 Subsidence Monitoring Program (LW101-103 SMP) forms a part of the Extraction Plan being developed for Longwalls 101 to 103 (herein referred to as Longwalls 101-103) of the approved UG1 Underground Mine. This LW101-103 SMP has been prepared by MCO, with input from Mine Subsidence Engineering Consultants [MSEC], to satisfy the requirements of Project Approval (08_0135) as modified and the NSW Department of Planning and Environment (DP&E) and NSW Division of Resources and Energy (DRE) (2015) Guidelines for the Preparation of Extraction Plans. The appointment of the team of suitably qualified and experienced persons (which includes representatives of MCO and MSEC) was endorsed by the Secretary of the DP&E.

**Purpose:** This LW101-103 SMP describes the subsidence monitoring program (subsidence impacts and subsidence effects) that forms part of the overall management of the consequential environmental impacts associated with the extraction of Longwalls 101-103.

**Scope:** This LW101-103 SMP covers areas within and proximal to the Longwalls 101-103 Study Area¹ (Figure 3).

Longwalls 101-103 are a subset of Longwalls 101-105, which together form the UG1 Underground Mine at the Moolarben Coal Complex. A separate Extraction Plan will be prepared for Longwalls 104 and 105 prior to secondary extraction of these longwalls commencing.

Since the Extraction Plan approval on the 21 September 2017, MCO has revised the mine plan to relocate Longwall 103 installation position to avoid an igneous intrusion and a mining First-Workings Plunge Panel where Longwall extraction is not viable. These changes are included in this Subsidence Monitoring Program amendment.

1.2 STRUCTURE OF THE LONGWALLS 101 TO 103 SUBSIDENCE MONITORING PROGRAM

The remainder of the LW101-103 SMP is structured as follows:

**Section 2** Describes the LW101-103 SMP revision status.

**Section 3** Outlines the statutory requirements applicable to the LW101-103 SMP.

**Section 4** Describes the Longwalls 101-103 extraction layout.

**Section 5** Describes the natural and built features at the surface.

**Section 6** Summarises the predicted subsidence parameters and impacts for the longwalls.

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¹ Longwalls 101-103 and the area of land within the furthest extent of the 26.5 degree (°) angle of draw and 20 millimetres (mm) predicted subsidence contour.
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<td>Describes the monitoring program.</td>
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<td>8</td>
<td>Describes the program to analyse subsidence effects, subsidence impacts, and environmental consequences.</td>
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<td>9</td>
<td>Describes the roles and responsibilities for MCO personnel and key contacts.</td>
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2.0 SUBSIDENCE MONITORING PROGRAM REVIEW AND UPDATE

In accordance with Condition 5, Schedule 6 of Project Approval (08_0135), this LW101-103 SMP will be reviewed within three months of the submission of:

- an Annual Review under Condition 4, Schedule 6;
- an incident report under Condition 7, Schedule 6;
- an audit under Condition 9, Schedule 6; or
- any modification to the conditions of Project Approval (08_0135) or Project Approval (05_0117) (unless the conditions require otherwise); and

if necessary, revised to the satisfaction of the Secretary of the DP&E, to ensure the plan is updated on a regular basis and to incorporate any recommended measures to improve environmental performance. Where this review leads to revisions to the LW101-103 SMP, then within four weeks of the review, the revised LW101-103 SMP will be submitted to the Secretary for approval.

2.1 ACCESS TO INFORMATION

In accordance with Condition 11, Schedule 6 ‘Access to Information’, MCO will make the approved LW101-103 SMP publicly available on the MCO website.
3.0 STATUTORY REQUIREMENTS

MCO’s statutory obligations are contained in:

- the conditions of the NSW Project Approval (05_0117) (as modified) and NSW Project Approval (08_0135) (as modified);
- the conditions of Commonwealth Approvals (EPBC 2007/3297, EPBC 2013/6926 and EPBC 2008/4444);
- relevant licences and permits, including conditions attached to the Environment Protection Licence (EPL No. 12932) and MLs (i.e. ML 1605, ML 1606, ML 1628, ML 1691 and ML 1715); and
- other relevant legislation.

Obligations relevant to this LW101-103 SMP are described below.

3.1 EP&A ACT APPROVAL

Condition 5(m), Schedule 4 of Project Approval (08_0135) requires the preparation of a Subsidence Monitoring Program (i.e. this LW101-103 SMP) as a component of the Extraction Plan. Condition 5(m), Schedule 4 of Project Approval (08_0135) states:

SUBSIDENCE

... Extraction Plan

5. The Proponent shall prepare and implement an Extraction Plan for all second workings on site to the satisfaction of the Secretary. Each extraction plan must:

... (m)include a Subsidence Monitoring Program, which has been prepared in consultation with DRE, to:

- describe the on-going subsidence monitoring program;
- provide data to assist with the management of the risks associated with subsidence;
- validate the subsidence predictions;
- analyse the relationship between the predicted and resulting subsidence effects and predicted and resulting impacts under the plan and any ensuing environmental consequences; and
- inform the contingency plan and adaptive management process;
The following graphical plans have been prepared in accordance with the DP&E and DRE (2015) Guidelines for the Preparation of Extraction Plans and are provided in Attachment 1:

- Plan 1: Extraction Plan Area and Mining Layout.
- Plan 2: Surface Features.
- Plan 3: Seam Geology.
- Plan 4: Seam Geology and Future Workings.
- Plan 5: Mining Titles and Land Ownership.
- Plan 6: Geological Sections.
- Plan 7: Subsidence Monitoring.

The document Moolarben Coal Complex: Moolarben Project Stage 2 – Longwalls 101 to 103, Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the Extraction Plan has been prepared by MSEC (2017) and includes predictions of the conventional and non-conventional subsidence impacts and subsidence effects of the Extraction Plan, incorporating any relevant information that has been obtained since Project Approval.

This LW101-103 SMP outlines the subsidence monitoring program prepared to satisfy that component of Condition 5(m), Schedule 4 of Project Approval (08_0135) relating to subsidence monitoring. The LW101-103 SMP is, among other things, designed to compare and validate the subsidence predictions outlined in MSEC (2017).

### 3.2 OTHER LEGISLATION

MCO will operate the Moolarben Coal Complex consistent with Project Approval (08_0135) and any other legislation that is applicable to an approved Part 3A Project under the EP&A Act.

The following Acts may be applicable to, but are not limited to, the conduct of the Moolarben Coal Complex:

- Crown Lands Act, 1989;
- Fisheries Management Act, 1994;
- Heritage Act, 1977;
- Mine Subsidence Compensation Act, 1961;
- Mining Act, 1992;
- National Parks and Wildlife Act, 1974;
• Biodiversity Conservation Act, 2016;
• Protection of the Environment Operations Act, 1997;
• Roads Act, 1993;
• Water Act, 1912;
• Water Management Act, 2000;
• Work Health and Safety Act, 2011; and

Relevant licences or approvals required under these Acts will be obtained as required.
4.0 **LONGWALLS 101-103 EXTRACTION LAYOUT AND SCHEDULE**

Longwalls 101-103, 103 Plunge Panel and the area of land within the furthest extent of the 26.5° angle of draw and 20 mm predicted subsidence contour (i.e. the Longwalls 101-103 Study Area) are shown on Figures 2 and 3. Longwall extraction will occur from the west to the east. The longwall layout includes approximately 311 metre (m) panel widths (void) with 20 m pillars (solid).

The geometry of Longwalls 101-103 is summarised in Table 1.

### Table 1: Geometry of Longwalls 101-103 Layout

<table>
<thead>
<tr>
<th>Longwall</th>
<th>Overall Void Length (including Installation Heading) (m)</th>
<th>Overall Void Width (including First Workings) (m)</th>
<th>Overall Tailgate Chain Pillar Width (m)</th>
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<td>2,561</td>
<td>311</td>
<td>20</td>
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<td>102</td>
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<td></td>
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<td>A</td>
<td>3,292</td>
<td>311</td>
<td>20</td>
</tr>
<tr>
<td>B</td>
<td>1,060</td>
<td>311</td>
<td>20</td>
</tr>
<tr>
<td>103</td>
<td>3,831</td>
<td>311</td>
<td>20</td>
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The dimensions of the headings are nominally 5.4 m wide and 3.4 m in height. The headings are connected approximately every 150 m by driving a cut-through from one heading to another which forms pillars of coal along the length of the gate road.

Following approval of the UG1 Optimisation Modification in April 2016, MCO has delineated a geological feature in Longwall 102 that prevents economic mining of this section, and has subsequently revised the longwall layout to incorporate a barrier pillar around this feature. The barrier pillar separating Longwalls 102A and 102B is approximately 140 m in length. In addition, following further detailed design, Longwalls 101-103 have been shortened by approximately 70 m to provide safe operational conveyor distance between the end of the longwalls and main headings.

A second geological intrusion has been located at the commencing end of LW103 preventing viable extraction by longwall mining methods in this area. As a consequence, the LW103 commencing position has been moved outbye of the influence of this structure, and a first workings and plunge panel has been established to partially extract the remanent coal that would otherwise become sterilised.

With the exception of these changes, the longwall geometry is the same as that for the approved UG1 Optimisation Modification, and MSEC (2017) and MSEC (2019) concludes that the overall impact assessments for the natural and built features are unchanged or reduced. The revised longwall layout is herein referred to as the Extraction Plan Layout.
The depth of cover to the Ulan Seam above Longwalls 101-103 varies between a minimum of approximately 47 m over Longwall 102A, and a maximum of 165 m over Longwall 102B. The seam floor generally dips from the south-west down to the north-east over the entire mining area.

Further description of the geology, seam structure and thickness, and depth of cover is provided in MSEC (2017).

The provisional extraction schedule for Longwalls 101-103 is provided in Table 2.

### Table 2: Provisional Extraction Schedule

<table>
<thead>
<tr>
<th>Longwall</th>
<th>Estimated Start Date</th>
<th>Estimated Duration</th>
<th>Estimated Completion Date</th>
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<tr>
<td>101</td>
<td>October 2017</td>
<td>8 months</td>
<td>June 2018</td>
</tr>
<tr>
<td>102 (A+B)</td>
<td>August 2018</td>
<td>12 months</td>
<td>August 2019</td>
</tr>
<tr>
<td>103</td>
<td>October 2019</td>
<td>10 months</td>
<td>July 2020</td>
</tr>
<tr>
<td>103 Plunge</td>
<td>March 2019</td>
<td>3 Months</td>
<td>May 2019</td>
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Open cut operations (OC1 and OC2) are located in the vicinity of the Longwall 102A tailgate and Longwalls 102A and 103 commencing ends. Open cut operations would not occur simultaneously with longwall mining in the immediate proximity of the adjacent longwall panel.
5.0 SURFACE FEATURES INCLUDED IN THE MONITORING PROGRAM

5.1 THE LONGWALLS 101-103 STUDY AREA

The Longwalls 101-103 Study Area in MSEC (2017) is defined as the surface area that is likely to be affected by the proposed mining of Longwalls 101-103 in the Ulan Seam by MCO. The extent of the Study Area has been calculated by combining the areas bounded by the following limits:

- a 26.5° angle of draw line from the extents of Longwalls 101-103; and
- the predicted vertical limit of subsidence, taken as the 20 mm subsidence contour resulting from the extraction of Longwalls 101-103 and 103 Plunge Panel.

As the depth of cover above the longwalls varies between 47 and 165 m, the 26.5° angle of draw line has been conservatively determined by drawing a line around the outer edge of the longwall voids at a horizontal distance that varies between 24 and 88 m.

There are features that lie outside the defined Longwalls 101-103 Study Area that are expected to experience either far-field movements, or valley related movements. The surface features which are sensitive to such movements have been identified and have also been included in the assessments provided in MSEC (2017).

Natural features identified within the Longwalls 101-103 Study Area include:

- drainage lines (DL7);
- cliffs (C5 and C6);
- minor cliffs and rock face features;
- steep slopes and land in general; and
- natural vegetation.

Aboriginal heritage sites have also been identified within the Longwalls 101-103 Study Area and surrounds.

The built features identified within the Longwalls 101-103 Study Area include:

- MCO assets (e.g. conveyor, OC4 South-West Haul Road, access roads, fences and a surface dam);
LONGWALLS 101-103 SUBSIDENCE MONITORING PROGRAM
MOOLARBEN COAL OPERATIONS

- Ulan-Wollar Road (closed and inaccessible to the public)\(^2\) (Mid-Western Regional Council [MWRC]); and
- Murragamba Road and Carrs Gap Road (closed and inaccessible to the public)\(^3\) (MWRC).

MSEC (2017) also considered built features that lay outside the Study Area that were expected to experience far-field movements. The built features included within the assessment beyond the extent of the Study Area included:

- 330 kV electricity transmission lines (ETL) and transmission structures (TransGrid);
- 66 kV/22 kV dual circuit powerline and future substation (to be located at the Remote Services Facilities) (Essential Energy);
- telecommunication (optical fibre and copper) cables (Telstra);
- Sandy Hollow Gulgong Railway (Australian Rail Track Corporation [ARTC]);
- Ulan-Wollar Road including road pavement, embankments, tunnels and culverts (MWRC);
- Ulan Road and bridge over the Sandy Hollow Gulgong Railway (MWRC); and
- survey control marks (e.g. Murragamba Trig Station).

The highwalls of the MCO open cut mining operations (e.g. OC1) and the underground mine entries from OC1 have also been included as part of the assessment.

The above natural and built features are discussed in detail in MSEC (2017) and summarised below.

The surface features are shown on Plan 2 (Attachment 1).

5.1.1 Drainage Lines

A number of small drainage lines have been identified above the longwalls and within the Study Area. Some of these drainage lines travel to the north and west towards OC1. Other drainage lines currently travel to the north and east towards the Murragamba Creek or Wilpinjong Creek. However, once OC4 is formed most of these drainage lines will either be diverted or drain to the mine water management system.

\(^2\) The route of Ulan-Wollar Road from the intersection with Ulan Road and around the northern end of Longwalls 101-103 has recently been realigned. The former road alignment (located closer to the northern ends of Longwalls 101-103) has been closed to the public at both ends. These changes to the Ulan-Wollar Road alignment are currently under application to be officially gazetted, and at this stage, the realigned section of the public road is located on land owned by MCO.

\(^3\) Murragamba Road and Carrs Gap Road directly overly Longwalls 101 to 103, as these roads are closed to the public, they have not been considered further.
Four drainage lines were identified by MSEC (2015) within the UG1 Study Area (i.e. associated with Longwalls 101-105) as part of the Subsidence Assessment for the *UG1 Optimisation Modification Environmental Assessment* (UG1 Optimisation Modification). All drainage lines identified in the vicinity of the Longwalls 101-103 Study Area are ephemeral as water only flows during, and for short periods after, each rain event (MSEC, 2015).

Of the drainage lines identified within the UG1 Study Area, only a section of drainage line DL7 overlies Longwalls 101-103. DL4 and DL5 are located within the approved out-of-pit emplacement and no longer exist and DL6 is not predicted to be impacted by subsidence caused by the extraction of Longwalls 101-103.

DL7 is a tributary of Murragamba Creek, which flows into Wilpinjong Creek.

### 5.1.2 Cliffs and Overhangs

Project Approval (08_0135) includes the following definition:

*Cliff:*

A continuous rock face, including overhangs, having a minimum length of 20 metres, a minimum height of 10 metres and a minimum slope of 2 in 1 (>63.4°).

Consistent with this definition, for the purposes of subsidence assessments, MSEC (2015; 2017) assessed cliffs as a continuous rock face having a minimum length of 20 m, height of 10 m and a minimum slope of 2 to 1 (i.e. having a minimum angle to the horizontal of 63.4°).

Six cliffs (cliffs C1 to C6) were identified by MSEC (2015) within the UG1 Study Area (i.e. associated with Longwalls 101-105) as part of the Subsidence Assessment for the *UG1 Optimisation Modification Environmental Assessment* (UG1 Optimisation Modification).

Of the cliffs identified within the UG1 Study Area, only cliffs C5 and C6 lie within the Longwalls 101-103 Study Area. Cliffs C1, C2, C3 and C4 are located within the approved out-of-pit emplacement or surface infrastructure and no longer exist.

Both cliffs are approximately 20 m in length, with a height of approximately 15 m and 10 m, respectively.
5.1.3 Minor Cliffs and Rock Face Features

Project Approval (08_0135) includes the following definitions:

Minor cliff:

A continuous rock face, including overhangs, which has a:

- minimum length of 20 metres and a height between 5 metres and 10 metres, or maximum length of 20 metres and a minimum height of 10 metres; and
- minimum slope of 2 to 1 (>63.4°).

Rock face feature:

A continuous rock face, including overhangs, which has a:

- minimum length of 20 metres and a height between 3 metres and 5 metres, or maximum length of 20 metres and a minimum height of 5 metres; and
- minimum slope of 2 to 1 (>63.4°).

MSEC (2015; 2017) identified a number of overhangs and smaller cliffs (i.e. minor cliffs and rock face features) within the UG1 Study Area, which are referred to as rock ledges.

5.1.4 Steep Slopes and Land in General

Project Approval (08_0135) includes the following definition:

Steep slope:

An area of land having a gradient between 1 in 3 (33% or 18.3°) and 2 in 1 (200% or 63.4°).

MSEC (2015; 2017) identified a number of steep slopes within the UG1 Study Area. Steep slopes were identified by MSEC as having a gradient of between 1 in 3 (i.e. having an angle to the horizontal of 18°) and 2 in 1 (i.e. having an angle to the horizontal of 63°) and were determined using 2 m contours of the UG1 Study Area (i.e. Longwalls 101-105).

Steep slopes have been identified to highlight areas where the existing ground slopes may be marginally stable. However, no significant slope failures have been observed in the Western or Southern Coalfields as a result of longwall mining (MSEC, 2017).
Land in general refers to the general landscape other than cliffs, minor cliffs, rock face features and steep slopes. Land in general includes other land features such as fire trails and vehicular tracks, however excludes surface features such as drains, diversions, and other MCO assets including the conveyor trace, open cut highwalls and out-of-pit emplacements which are addressed elsewhere in the Extraction Plan.

5.1.5 Natural Vegetation

Natural Vegetation

Natural vegetation covers the majority of the Study Area.

Threatened, Protected Species or Critical Habitats

Five threatened flora species have been recorded at the Moolarben Coal Complex, including (Moolarben Biota, 2006; Ecovision Consulting, 2008; EMGA Mitchell McLennan, 2013):

- *Diuris tricolor* (Pine Donkey Orchid) – vulnerable under the BC Act.
- *Eucalyptus cannonii* (Capertee Stringybark) – vulnerable under the BC Act.
- *Leucochrysum albicans var tricolor* (Hoary Sunray) – endangered under the EPBC Act.
- *Pomaderris queenslandica* (Scant Pomaderris) – endangered under the BC Act.

Of the above, only Scant Pomaderris was recorded within the Longwalls 101-103 Study Area.

Across the Moolarben Coal Complex, a total of 32 threatened and/or migratory fauna species, consisting of seven mammal species (including six microbat species) and 25 bird species have been recorded by Moolarben Biota (2006), Ecovision Consulting (2008) and EMGA Mitchell McLennan (2013) at the Moolarben Coal Complex. Only a subset of the threatened and migratory species recorded at the Moolarben Coal Complex has been recorded within the Longwalls 101-103 Study Area.

Potential cave-dwelling bat roosting sites have been identified across the UG1 Longwalls 101-103 Study Area, including cliffs C5 and C6 and minor cliffs.

Literature reviews and aquatic ecology studies undertaken at the Moolarben Coal Complex indicate that there are no threatened aquatic plants, fish or macroinvertebrate species or populations (as
listed under EPBC Act or under the NSW *Fisheries Management Act, 1994* listed or found in the upper Goulburn River (Ecovision Consulting, 2008).

No GDEs have been identified in the Longwalls 101-103 Study Area.

**Endangered Ecological Communities**

Eco Logical Australia Pty Ltd (Eco Logical) (2016) identified the following endangered ecological communities (EEC) and critically endangered ecological communities (CEEC), listed under the BC Act and under the EPBC Act, in the Longwalls 101-103 Study Area:

- **White Box, Yellow Box, Blakely’s Red Gum Grassy Woodland and Derived Native Grassland**, listed as an EEC under the BC Act and CEEC under the EPBC Act.
- **Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions**, listed as an EEC under the BC Act.

In addition to the above, Eco Logical (2016) also identified *Central Hunter Valley Eucalypt Forest and Woodland*, listed as a CEEC under the EPBC Act. This CEEC was listed in May 2015 and does not apply to the approved Stage 1 and Stage 2 mining operations pursuant to section 158A of the EPBC Act.

### 5.2 PUBLIC UTILITIES

#### 5.2.1 Railways and Culverts

There are no railways in the Longwalls 101-103 Study Area.

The Sandy Hollow Gulgong Railway is located to the north and east of Longwalls 101-103 and the nearest edges vary from approximately 380 m to 470 m from the rail track.

Drainage culverts are located along the Sandy Hollow Gulgong Railway, the nearest of which is at Murragamba Creek crossing, over 1.2 km from Longwall 103.

A baseline subsidence monitoring survey of the “Railway” Line will be undertaken prior to mining within 400 m of the Longwall 101 take-off point. Subsequent monitoring proposed as part of this LW101-103 SMP will reference the FF Line along Ulan-Wollar Road which will trigger any requirement for further railway monitoring.
5.2.2 Roads and Culverts

The locations of roads including Ulan-Wollar Road, Murragamba Road, Carrs Gap Road, Ulan Road, other access roads and four-wheel drive tracks within and adjacent to the Longwalls 101-103 Study Area are shown on Plan 2 (Attachment 1) and are summarised below.

**Ulan-Wollar Road**

Ulan-Wollar Road runs adjacent to the Sandy Hollow Gulgong Railway at distances of 190 m or more from Longwalls 101-103. Ulan-Wollar Road is a sealed bitumen pavement with no kerb and gutter.

The route of Ulan-Wollar Road from the intersection with Ulan Road and around the northern end of Longwalls 101-103 has recently been realigned by construction of a new road pavement. The former road alignment (located closer to the northern ends of Longwalls 101-103) has been closed to the public at both ends. These changes to the Ulan-Wollar Road alignment are currently under application to be officially gazetted, and at this stage, the realigned section of the public road is located on land owned by MCO.

The nearest publicly accessible sections of Ulan-Wollar Road to the proposed longwalls are approximately 250 m from Longwall 101 and 335 m from Longwall 103. The nearest closed sections of Ulan-Wollar Road are approximately 100 m from Longwall 103.

**Murragamba Road and Carrs Gap Road**

Sections of Murragamba Road and Carrs Gap Road directly overly Longwalls 101-103, as the roads are closed to the public, they will be managed together with other private access roads and tracks as part of the Underground Subsidence Principal Hazard Management Plan to manage Work Health and Safety risks for personnel working at MCO.

**Ulan Road**

Ulan Road is located to the north-west of Longwalls 101 to 103, more than 1 km from the nearest longwall with an open cut pit between the road and the longwalls, and is not expected to experience measurable conventional ground subsidence movements or far-field horizontal movements (MSEC, 2017).
Other Access Roads and Tracks

All other roads are unsealed access roads and are inaccessible to the public. A number of four-wheel drive tracks are located throughout the Longwalls 101-103 Study Area, one of which is above the south-western end of Longwall 103.

Road Drainage Culverts

No drainage culverts beneath roads were identified within the Study Area. The nearest drainage culvert on Ulan-Wollar Road is located approximately 1.2 km to the south-east at Murragamba Creek.

An embankment and twin tunnels have also been constructed beneath the Ulan-Wollar Road along the alignment of the conveyor, approximately 720 m from Longwall 101.

5.2.3 Bridges

A road bridge is located along Ulan Road, over the Sandy Hollow Gulgong Railway line, and is 1.2 km from Longwall 101.

5.2.4 Electrical Services

66 kV/22 kV Dual Circuit Powerline

A 66 kV/22 kV dual circuit powerline owned by Essential Energy runs adjacent to Ulan-Wollar Road and the Sandy Hollow Gulgong Railway Line. The 66 kV/22 kV dual circuit powerline is supported on timber poles with guy wires at changes in the alignment of the powerline for additional lateral restraint.

The nearest sections of the 66 kV/22 kV dual circuit powerline are approximately 90 metres (m) from the northern (finishing) end of Longwall 103 (pole 70548) and 230 m from the finishing end of Longwall 101 (pole 70540), and beyond the proposed Essential Energy substation location within the Remote Services Facilities.

Substation

The future Essential Energy substation to be located at the Remote Services Facilities is outside of the Longwalls 101-103 Study Area.
330 kV Electricity Transmission Line

A 330 kV ETL (Wollar-Wellington 330 kV High Voltage Line) owned by TransGrid runs adjacent to Ulan-Wollar Road and the Sandy Hollow Gulgong Railway Line.

The 330 kV ETL and towers are located to the north-east of Longwalls 101-103 and the longwalls will not pass beneath these electrical services. The nearest tension tower (106) is located 620 m to the north-east of the northern corner of Longwall 101. The nearest suspension tower is located approximately 340 m to the north of the northern corner of Longwall 101.

5.2.5 Telecommunication Infrastructure

Telecommunication infrastructure in the vicinity of the Study Area includes an optical fibre cable and a copper cable (both owned by Telstra). The Telstra telecommunication cables are located along the northern side of Ulan-Wollar Road and adjacent to the Sandy Hollow Gulgong Railway.

The telecommunication cables are located to the north and east of the Study Area and are approximately 240 m from Longwall 101 at their nearest point. To the east, the telecommunication cables are approximately 335 m from Longwall 103.

5.3 FARM LAND AND FACILITIES

With the exception of a portion of land (Lot 7010, DP1025345) owned by The State of NSW (Crown Land) and a number of roads (and associated easements) owned by the MWRC, all other land (including farm land and facilities) within the Longwalls 101-103 Study Area is owned by MCO.

5.3.1 Fences

Fences are located within the Longwalls 101-103 Study Area and are constructed in a variety of ways, generally using either timber or metal materials.

5.3.2 Surface Dam

A surface dam (A02d03) is located on MCO owned land within the Longwalls 101-103 Study Area near the coal barrier between Longwalls 102A and 102B, and adjacent the Longwall 103 tailgate.
5.4 MINE INFRASTRUCTURE

5.4.1 Open Cut Highwalls

The tailgate of Longwall 102A is located adjacent to the partially backfilled OC1. Extraction of Longwall 102A may result in localised movements on the adjacent highwall face. OC1 will not be operating in this area and access will be restricted during the extraction of Longwall 101 and the start of Longwall 102A.

The commencing ends of Longwalls 102A and 103 are located adjacent to the approved OC1/OC2 mining area. Open cut mining in OC1/OC2 is scheduled following the completion of mining in the immediate proximity of the adjacent longwall panel.

5.4.2 Out-of-Pit Waste Rock Emplacement

The approved out-of-pit waste rock emplacement area is partially located within the Longwalls 101-103 Study Area, above the maingate of Longwall 103.

The top of the approved out-of-pit waste rock emplacement is proposed to be relatively flat with a top surface level of approximately 530 m to 540 m Australian Height Datum (AHD). The slopes of the batters formed at the sides of the emplacement area are proposed to vary from grades of approximately 1 in 4 to 1 in 6, however because the natural surface levels surrounding the emplacement in the Longwalls 101-103 Study Area are close to the proposed finishing level (530 m to 540 m AHD) there will be minimal to no batters. The maximum depth of fill above Longwall 103 m will be about 10 m to 15 m.

The approved out-of-pit waste rock emplacement will be completed prior to the extraction of Longwall 103.

5.4.3 Stage 2 ROM Facilities and Conveyor

The Stage 2 run-of-mine (ROM) Facilities have been constructed outside the Longwalls 101-103 Study Area and are located adjacent to the maingate of future Longwall 105, approximately 660 m from Longwall 103.

The conveyor from the Stage 2 ROM Facilities to the CHPP has been constructed and is aligned diagonally across Longwalls 101-103 and includes an access road adjacent to the conveyor.
5.4.4 Haul Road

A haul road (OC4 South-West Haul Road) is located above Longwalls 102A and 103.

5.5 ITEMS OF ARCHAEOLOGICAL SIGNIFICANCE

5.5.1 Aboriginal Heritage Sites

There are 17 Aboriginal heritage sites identified within the Study Area which comprise rock shelters with potential archaeological deposits (PAD), rock shelters with artefacts and PAD, isolated finds or artefact scatters.

Detailed descriptions of the Aboriginal heritage sites are provided in the report by Niche Environment and Heritage (2017).

5.6 SURVEY CONTROL MARKS

No survey control marks are located within the Study Area. The Murragamba Trig Station is located above the future Longwall 105, approximately 370 m to the south-east of Longwall 103.

Other survey marks in the vicinity of Longwalls 101-103 are predominantly located along Ulan-Wollar Road and the Sandy Hollow Gulgong Railway.
6.0 SUBSIDENCE PARAMETERS AND SUBSIDENCE IMPACTS DUE TO LONGWALLS 101-103 EXTRACTION

MSEC (2017) provides a detailed description of the development of mine subsidence and the method used to predict the mine subsidence movements resulting from the extraction of the longwalls. The report includes the maximum predicted conventional subsidence parameters for the longwalls (Chapter 4 of MSEC [2017]) including:

- Incremental Subsidence Parameters, which are the predicted subsidence parameters due to the extraction of a single longwall.
- Total Subsidence Parameters, which include the accumulated subsidence parameters after the completion of each longwall within a series of longwalls.

The maximum predicted incremental conventional subsidence from the extraction of Longwalls 101-103 is 2,250 mm.

A comparison of the maximum predicted conventional total subsidence parameters, for the Extraction Plan Layout and the Approved Layout for Longwalls 101-103, is provided in MSEC (2017). MSEC (2017) concludes that the maximum predicted total subsidence parameters are the same (e.g. maximum predicted total conventional subsidence of 2,400 mm).

The predictions of conventional subsidence parameters do not include the valley related upsidence and closure movements, nor the effects of faults and other geological structures.

6.1 PREDICTED SUBSIDENCE PARAMETERS AND IMPACTS FOR THE NATURAL AND BUILT FEATURES WITHIN THE STUDY AREA AND SURROUNDS

MSEC (2017) provides a comprehensive description of the predicted subsidence parameters and impact assessments for each of the natural and built features that are located within the Study Area, due to the extraction of Longwalls 101-103. Additionally, natural and built features that are located outside the Longwalls 101-103 Study Area, which may be subjected to far-field movements and may be sensitive to the predicted subsidence parameters, were also included in the assessments. Further descriptions are provided in MSEC (2019) and Mine Advice (2019).

In particular, impact assessments were completed for the following surface features:

- drainage line (DL7);
- cliffs (C5 and C6);
• rock ledges (minor cliffs and rock face features);
• steep slopes and land in general;
• natural vegetation (including threatened, protected species or critical habitats and EECs);
• MCO assets and mine infrastructure (e.g. Stage 2 ROM Facilities and conveyor, OC4 South-West Haul Road, access roads, fences and a surface dam, open cut highwalls and out-of-pit waste rock emplacement);
• ARTC assets (e.g. Sandy Hollow Gulgong Railway);
• MWRC assets (e.g. Ulan-Wollar Road including road pavement, embankments, tunnels and culverts, Murragamba Road, Carrs Gap Road, Ulan Road and bridge over Sandy Hollow Gulgong Railway, other access roads and four wheel drive tracks);
• TransGrid assets (e.g. 330 kV ETL and transmission structures);
• Essential Energy assets (e.g. 66 kV/22 kV dual circuit powerline supported on timber poles and proposed substation);
• Telstra assets (e.g. optical fibre and copper cables);
• Aboriginal heritage sites; and
• survey control marks (Murragamba Trig Station).

The monitoring program described below was developed in consideration of the predicted subsidence parameters and subsidence impacts outlined in MSEC (2017). MSEC (2019) considered the Revised Extraction Plan Layout and considered that “No revisions are recommended for the approved Extraction Plan or the approved Subsidence Monitoring Program.”
7.0 MONITORING

7.1 INTRODUCTION

The objectives of the monitoring program are:

- To monitor the subsidence effects associated with Longwalls 101-103 extraction.
- To summarise and consolidate the various monitoring programs presented in each of the key component plans of the UG1 Longwalls 101-103 Extraction Plan. These include:
  - the UG1 Longwalls 101 to 103 Water Management Plan (LW101-103 WMP);
  - the UG1 Longwalls 101 to 103 Land Management Plan (LW101-103 LMP);
  - the UG1 Longwalls 101 to 103 Biodiversity Management Plan (LW101-103 BMP);
  - the UG1 Longwalls 101 to 103 Heritage Management Plan (LW101-103 HMP);
  - the UG1 Longwalls 101 to 103 Built Features Management Plans, including:
    - the UG1 Longwalls 101 to 103 Built Features Management Plan – TransGrid (LW101-103 BFMP-TransGrid);
    - the UG1 Longwalls 101 to 103 Built Features Management Plan – Essential Energy (LW101-103 BFMP-EE);
    - the UG1 Longwalls 101 to 103 Built Features Management Plan – Australian Rail Track Corporation (LW101-103 BMFP-ARTC);
    - the UG1 Longwalls 101 to 103 Built Features Management Plan – Telstra (LW101-103 BFMP-Telstra);
    - the UG1 Longwalls 101 to 103 Built Features Management Plan – Mid-Western Regional Council (LW101-103 BFMP-MWRC); and
  - the UG1 Longwalls 101 to 103 Public Safety Management Plan.
- To analyse the relationship between the subsidence effects and subsidence impacts of the Extraction Plan and any ensuing environmental consequences.
- To validate subsidence predictions.
- To provide subsidence data to improve the predictive methods and provide a better understanding of the underlying factors contributing to ground movement.

The subsidence monitoring program is composed of subsidence parameter monitoring that is summarised in Table 3 and subsidence impact/environmental consequence monitoring as summarised in Table 4.
### Table 3: Subsidence Parameter Monitoring Components

<table>
<thead>
<tr>
<th>Monitoring Component</th>
<th>Description</th>
<th>Frequency</th>
<th>Relevant Management Plan</th>
</tr>
</thead>
</table>
| “103A” Line | Main monitoring line traversing 103 Plunge Panel first workings | • Prior to commencement of pillar formation and plunging  
• Within 3 months following completion of plunging | Extraction Plan |
| “A” Line | Main monitoring line traversing Longwalls 101-103 | • Prior to commencement of Longwall 101 extraction.  
• Within three months following completion of each of Longwalls 101, 102 and 103. | Extraction Plan |
| “B” Line | Longitudinal monitoring line at Longwall 101 commencing end | • Prior to commencement of Longwall 101 extraction.  
• At 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 101 commencing end.  
• Within three months following completion of Longwall 101. | Extraction Plan |
| “C” Line | Longitudinal monitoring line at Longwall 101 finishing end | • Prior to secondary extraction within 400 m of the Longwall 101 take-off point.  
• At 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 101 take-off point.  
• Within three months following completion of Longwall 101. | Extraction Plan |
| “D” Line | Longitudinal monitoring line at Longwall 102 finishing end | • Prior to secondary extraction within 400 m of the Longwall 102 take-off point.  
• At 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 102 take-off point.  
• Within three months following completion of Longwall 102. | Extraction Plan |
| “E” Line | Longitudinal monitoring line at Longwall 103 finishing end | • Prior to secondary extraction within 400 m of the Longwall 103 take-off point.  
• At 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 103 take-off point.  
• Within three months following completion of Longwall 103. | Extraction Plan |
<table>
<thead>
<tr>
<th>Monitoring Component</th>
<th>Description</th>
<th>Frequency</th>
<th>Relevant Management Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>“BC” Line</td>
<td>OC1 Highwall / UG1 Entries</td>
<td>• Prior to commencement of Longwall 101 extraction.</td>
<td>Extraction Plan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• When the active longwall face is approximately 500 m from the Longwall 101 commencing end.</td>
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<td>• When the active longwall face in Longwall 102 retreats past the Longwall 101 commencing end.</td>
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<tr>
<td></td>
<td></td>
<td>• When the active longwall face in Longwall 102 retreats approximately 500 m past the Longwall 101 commencing end.</td>
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</tbody>
</table>
Table 3 (Continued): Subsidence Parameter Monitoring Components

<table>
<thead>
<tr>
<th>Monitoring Component</th>
<th>Description</th>
<th>Frequency</th>
<th>Relevant Management Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Railway” Line</td>
<td>Sandy Hollow Gulgong Railway Line</td>
<td>• Prior to mining within 400 m of the Sandy Hollow Gulgong Railway Line.</td>
<td>BFMP-ARTC</td>
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<td></td>
<td></td>
<td>• At any time in case of fault or emergency and where requested by ARTC.</td>
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<td></td>
<td></td>
<td>• In the event monitoring detects movements in excess of survey/design tolerances (as advised by ARTC).</td>
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</tr>
<tr>
<td>“FF” Line</td>
<td>Along the alignment of Ulan-Wollar Road in the vicinity of Longwalls 101-103</td>
<td>• Prior to commencement of Longwall 101 extraction.</td>
<td>LW101-103 BFMP-MWRC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• When mining reaches the “A” Line for Longwall 101.</td>
<td>LW101-103 BFMP-ARTC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Prior to secondary extraction within 400 m of the Longwall 101 take-off point.</td>
<td>LW101-103 BFMP-TRANSGRID</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• At 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the longwall take-off point.</td>
<td>LW101-103 BFMP-TELSTRA</td>
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<tr>
<td></td>
<td></td>
<td>• Within two weeks following completion of longwall recovery from each of Longwalls 101, 102 and 103.</td>
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<tr>
<td></td>
<td></td>
<td>• Within three months following completion of longwall recovery from each of Longwalls 101, 102 and 103.</td>
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<td></td>
<td></td>
<td>• At any time in case of fault or emergency and where requested by relevant asset owners.</td>
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</tr>
<tr>
<td>330 kV ETL – Towers 102 to 111</td>
<td>Tower survey – 4 x leg mounted prisms at each tower (measuring differential separation) as well as target (bolt) locations on both earth peaks of each tower and ground network monitoring at the base of each tower</td>
<td>• Prior to commencement of Longwall 101 extraction.</td>
<td>LW101-103 BFMP-TRANSGRID</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• When mining reaches the “A” Line for Longwall 101.</td>
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<tr>
<td></td>
<td></td>
<td>• At 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the longwall take-off point.</td>
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<td></td>
<td></td>
<td>• Within two weeks following completion of longwall recovery from each of Longwalls 101, 102 and 103.</td>
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<td></td>
<td>• Within three months following completion of longwall recovery from each of Longwalls 101, 102 and 103.</td>
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<td></td>
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<td>• At any time in case of fault or emergency and where requested by TransGrid.</td>
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</table>
### Table 3 (Continued): Subsidence Parameter Monitoring Components

<table>
<thead>
<tr>
<th>Monitoring Component</th>
<th>Description</th>
<th>Frequency</th>
<th>Relevant Management Plan</th>
</tr>
</thead>
</table>
| 66 kV/22 kV dual circuit powerline – power poles within 300 m of the relevant longwall | Structure survey – 2 x monitoring points at each timber pole | • Prior to commencement of longwall extraction.  
• Prior to secondary extraction within 400 m of the longwall take-off point.  
• At 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the longwall take-off point.  
• Within three months following completion of longwall recovery from each of Longwalls 101, 102 and 103. | LW101-103 BFMP-EE |
| Essential Energy substation | Subsidence monitoring at survey points installed around the substation | • Prior to commencement of Longwall 101 extraction.  
• Prior to secondary extraction within 400 m of the Longwall 101 take-off point.  
• At 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the longwall take-off point.  
• Within three months following completion of longwall recovery from each of Longwalls 101, 102 and 103. | LW101-103 BFMP-EE |
| Survey Station | Murragamba Trig Station | • Prior to commencement of Longwall 101 extraction.  
• Within three months following completion of active mining at UG1. | Extraction Plan |
Table 4: Subsidence Impact and Environmental Consequences Monitoring Components

<table>
<thead>
<tr>
<th>Extraction Plan Component</th>
<th>Aspect</th>
<th>Sites</th>
<th>Frequency</th>
<th>Purpose/Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>LW101-103 LMP</td>
<td>Visual inspection of cliffs</td>
<td>C5 and C6</td>
<td>Prior to commencement of Longwall 101 extraction.</td>
<td>Evidence of subsidence impacts compared to baseline records by visual inspection of location, physical description (e.g. length and height of cliffs, angle to horizontal) and general condition of cliffs.</td>
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<td></td>
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<td></td>
<td>Prior to commencement of Longwall 103 extraction.</td>
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<td>Within one month of the completion of Longwall 103 extraction.</td>
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<tr>
<td>Minor cliffs, rock face</td>
<td>Representative sites within the Study Area.</td>
<td></td>
<td>Prior to commencement of Longwall 101 extraction.</td>
<td>Evidence of subsidence impacts compared to baseline observations (e.g. photography, rockfalls, cliff instabilities, displacement of or dislodgement of boulders or slabs surface cracking) and total face area to be recorded.</td>
</tr>
<tr>
<td>features, steep slopes</td>
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<td></td>
<td>Opportunistic visual observations during mining.</td>
<td></td>
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<tr>
<td>and land in general</td>
<td></td>
<td></td>
<td>Within one month following completion of Longwall 103.</td>
<td></td>
</tr>
<tr>
<td>LW101-103 BMP</td>
<td>Flora and fauna habitats</td>
<td>Longwall panel traverses.</td>
<td>During spring, prior to longwall extraction beneath the transect.</td>
<td>Evidence of subsidence impacts compared to baseline condition (e.g. surface cracking, ponding, deterioration in tree health outside natural variations, weed incursion and/or infestation).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>During spring, for two years following longwall extraction beneath the transect.</td>
<td>Nature and extent of any impacts on flora and fauna habitats and observations of terrestrial fauna.</td>
</tr>
<tr>
<td></td>
<td>Floristic monitoring sites.</td>
<td></td>
<td>During spring, prior to longwall extraction beneath the monitoring site.</td>
<td>The extent and condition of identified threatened flora species or EECs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>During spring, for two years following longwall extraction beneath the monitoring site.</td>
<td>Collection of data at each site for comparison to baseline condition, including:</td>
</tr>
<tr>
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<td></td>
<td>• Canopy health and defoliation.</td>
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<td></td>
<td>• Vegetation structure.</td>
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<td>• Nature and extent of any impacts on flora and fauna habitats.</td>
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<td></td>
<td>• Evidence of any impacts on terrestrial fauna.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Condition and extent of threatened species or EECs (if present).</td>
</tr>
</tbody>
</table>
### Table 4 (Continued): Subsidence Impact and Environmental Consequences Monitoring Components

<table>
<thead>
<tr>
<th>Extraction Plan Component</th>
<th>Aspect</th>
<th>Sites</th>
<th>Frequency</th>
<th>Purpose/Parameters</th>
</tr>
</thead>
</table>
| LW101-103 BMP (continued) | Flora and fauna habitats (continued) | Targeted cliff line monitoring | Prior to commencement of longwall extraction beneath the potential roosting site.  
Between October and February after completion of longwall extraction. | Evidence of subsidence impacts to features that provide potential bat roosting sites compared to baseline condition (e.g. rockfalls, displacement of or dislodgement of boulders or slabs, or fracturing). |
| LW101-103 WMP | Drainage line | DL7 above Longwall 103. | Prior to undermining of drainage line DL7.  
Within three months of undermining of drainage line DL7.  
An inspection every six months for one year after a longwall undermines drainage line DL7. | Evidence of subsidence impacts compared to baseline records by visual inspection and photographic record (noting any areas of active erosion, sediment deposition, water ponding or streambed cracking). |
| Surface Water Flow and Quality | SW04 and SW16 (Murragamba & Wilpinjong Creek) | In accordance with the approved complex-wide Surface Water Management Plan. | In accordance with the approved complex-wide Surface Water Management Plan. |
| Groundwater extraction, groundwater levels, groundwater quality and leachate/seepage losses from water and water storages | Bores PZ127, PZ130, PZ157, PZ186, PZ187, PZ188, PZ189, PZ179, Bore A, Bore B and Bore C. | In accordance with the approved complex-wide Groundwater Management Plan, whilst serviceable. | In accordance with the approved complex-wide Groundwater Management Plan. |
| | Major Surface Water Dams. | In accordance with the approved complex-wide Surface Water Management Plan. | Water levels. |
| LW101-103 HMP | Aboriginal Heritage | PAD 3 Moolarben Coal. | Baseline recording where not sufficiently recorded.  
Within three to six months of undermining. | To identify and document whether any subsidence impacts have arisen from mining activities at PAD 3 Moolarben Coal, the monitoring requirements described in section 5.9.1 of the approved complex-wide Heritage Management Plan will be implemented for this site. |
Table 4 (Continued): Subsidence Impact and Environmental Consequences Monitoring Components

<table>
<thead>
<tr>
<th>Extraction Plan Component</th>
<th>Aspect</th>
<th>Sites</th>
<th>Frequency</th>
<th>Purpose/Parameters</th>
</tr>
</thead>
</table>
| LW101-103 BFMP-EE | Condition of 66 kV/22 kV dual circuit powerline | Timber poles. | • Prior to commencement of Longwall 101 extraction.  
• Prior to secondary extraction within 400 m of the Longwall 101 take-off positions.  
• In the event monitoring detects movements in excess of survey/design tolerances.  
• At any time in case of fault or emergency and where requested by Essential Energy.  
• Routinely as per Essential Energy inspections.  
• Within three months of longwall completion (e.g. longwall has been relocated from the final end of block mining position). | Evidence of subsidence impacts compared to baseline record (photographic record) and targeting the identification of:  
• surface cracking (particularly in areas around power pole foundations);  
• surface humps (particularly in areas around power pole foundations);  
• damage to poles, conductors and/or powerlines;  
• reduced ground clearance (vegetation management to be completed by Essential Energy);  
• tilting of power poles [using 2 x reflectors] (resulting in increased/decreased tension in conductors); and  
• bent cross-arms or insulators. |
| Condition of substation | Essential Energy substation. | | • Prior to secondary extraction within 400 m of the Longwall 101 take-off positions.  
• In the event monitoring detects movements in excess of survey/design tolerances.  
• Additional opportunistic observations of subsidence impacts will be conducted during routine works by MCO and its contractors.  
• Within three months of longwall completion (e.g. longwall has been relocated from the final end of block mining position). | Evidence of subsidence impacts compared to design/baseline records by visual inspection of location (e.g. surface cracking; surface humps; and tilting of foundations). |
### Table 4 (Continued): Subsidence Impact and Environmental Consequences Monitoring Components

<table>
<thead>
<tr>
<th>Extraction Plan Component</th>
<th>Aspect</th>
<th>Sites</th>
<th>Frequency</th>
<th>Purpose/Parameters</th>
</tr>
</thead>
</table>
| LW101-103 BFMP-TRANSGRID  | Condition of 330 kV ETL | Towers 102 to 111. | • Prior to commencement of Longwall 101. \*\*
• Routinely as per TransGrid inspections.
• In the event monitoring detects movements in excess of survey/design tolerances (as advised by TransGrid). | Evidence of subsidence impacts compared to baseline record (photographic record) (e.g. land clearance, vegetation clearance, road clearance, integrity and function of support clamps or other items). |
| LW101-103 BFMP-MWRC       | Subsidence impact inspection of Ulan-Wollar Road | Road pavements, culverts and other furniture. | • Prior to commencement of Longwall 101 extraction.
• If/when ground movement (in excess of survey accuracy) is detected during monitoring of the FF Line.
• At any time in case of an emergency and requested by MWRC.
• Routinely as per MWRC inspections.
• Following completion of active mining at UG1. | Evidence of subsidence impacts compared to baseline record (photographic record) and targeting the identification of:
• impacts to the pavement surface including cracks, buckling and stepping;
• impacts to the visible surfaces of pipes/culverts including cracking, buckling, shearing, and collapse; and
• visible impacts to furniture. |
### Table 4 (Continued): Subsidence Impact and Environmental Consequences Monitoring Components

<table>
<thead>
<tr>
<th>Extraction Plan Component</th>
<th>Aspect</th>
<th>Sites</th>
<th>Frequency</th>
<th>Purpose/Parameters</th>
</tr>
</thead>
</table>
| LW101-103 BFMP-TELSTRA    | Optical Fibre Cable | Signal integrity testing using a Remote Fibre Monitoring System (RFMS). | • Prior to secondary extraction within 400 m of the Longwall 101 take-off point.  
• Continuous (monitoring commencement to occur as longwall face approaches within 400 m of the cable to establish more frequent communications with Telstra). | Establish pre-mining condition by taking a baseline RFMS measurement.  
Monitor for loss in signal using Optical Time Domain Reflectometry.  
Establish pre-mining condition by taking a baseline RFMS measurement.  
Monitor for loss in signal using Optical Time Domain Reflectometry.  
Establish pre-mining condition by taking a baseline RFMS measurement.  
Monitor for loss in signal using Optical Time Domain Reflectometry.  
In the event monitoring identifies ground movements along FF Line (in excess of survey accuracy), monitor for a significant variation from the baseline reading.  
Evidence of subsidence impacts and targeting the identification of:  
• movement of the cable; and  
• ground compression / tension.  
Evidence of subsidence impacts and targeting the identification of:  
• movement of the cable; and  
• ground compression / tension.  
Evidence of subsidence impacts and targeting the identification of:  
• any defects or deformation of the rail line and associated infrastructure; and  
• changes to the visible surfaces of the culverts including cracking, buckling, shearing, and collapse. |
| LW101-103 BFMP-ARTC       | Copper Cable | Signal integrity testing using a resistance test. | • Prior to secondary extraction within 400 m of the Longwall 101 take-off point.  
• Following identification of ground movements along FF Line (in excess of survey accuracy). | Establish pre-mining condition by taking a baseline resistance measurement.  
In the event monitoring identifies ground movements along FF Line (in excess of survey accuracy), monitor for a significant variation from the baseline reading.  
Evidence of subsidence impacts and targeting the identification of:  
• movement of the cable; and  
• ground compression / tension.  
Evidence of subsidence impacts and targeting the identification of:  
• any defects or deformation of the rail line and associated infrastructure; and  
• changes to the visible surfaces of the culverts including cracking, buckling, shearing, and collapse. |
| LW101-103 BFMP-ARTC       | Sandy Hollow Gulgong Railway | Subsidence impact inspection. | Prior to secondary extraction within 400 m of the Longwall 101 take-off position.  
If/when ground movement (in excess of survey accuracy) is detected during monitoring of the FF Line.  
Routinely as per ARTC inspections.  
At any time in case of fault or emergency and where requested by ARTC. | Evidence of subsidence impacts and targeting the identification of:  
• any defects or deformation of the rail line and associated infrastructure; and  
• changes to the visible surfaces of the culverts including cracking, buckling, shearing, and collapse. |
7.2 SUBSIDENCE PARAMETER MONITORING COMPONENTS

The components of the program to monitor subsidence parameters are illustrated in Plan 7 (Subsidence Monitoring) prepared in accordance with the DP&E and DRE (2015) Guidelines for the Preparation of Extraction Plans) provided in Attachment 1 and described below.

7.2.1 “103A” Line

The location of the “103A” Line is shown on Plan 7 in Attachment 1. The line is located across and perpendicular to 103 Plunge Panel.

The “103A” Line will be composed of survey marks established at a spacing of approximately 15 m to 20 m. Survey marks will be comprised of either:

- concrete nails set in rock; or
- star pickets.

Due to the practicalities of following existing tracks and steep terrain, bends in the survey line will have to be incorporated.

Prior to installation of the survey marks, consideration will be given to the presence of Aboriginal heritage sites and if detected the survey marks will be located so as to avoid these heritage sites.

The purpose of the “A” Line is to measure the vertical subsidence associated with extraction and the total vertical subsidence associated with overall extraction.

The frequency of monitoring the “103A” Line will be:

- prior to commencement of pillar formation and plunging;
- within three months following completion of each plunging;
- more frequently if directed by the Principal Subsidence Engineer NSW DRE.

Monitoring of the “103A” Line will provide information of relevance to some of the management plans listed in Section 7.1.
7.2.2 “A” Line

The location of the “A” Line is shown on Plan 7 in Attachment 1. The line is located across and perpendicular to Longwalls 101-103.

The “A” Line will be composed of survey marks established at a spacing of approximately 15 m to 20 m. Survey marks will be comprised of either:

- concrete nails set in rock; or
- star pickets.

Due to the practicalities of following existing tracks and steep terrain, bends in the survey line will have to be incorporated.

Prior to installation of the survey marks, consideration will be given to the presence of Aboriginal heritage sites and if detected the survey marks will be located so as to avoid these heritage sites.

The purpose of the “A” Line is to measure the subsidence parameters (e.g. subsidence, tilt, strain) associated with extraction of each longwall panel and the total subsidence parameters associated with overall extraction.

The frequency of monitoring the “A” Line will be:

- prior to commencement of Longwall 101 extraction;
- within three months following completion of each of Longwalls 101, 102 and 103; and
- more frequently if directed by the Principal Subsidence Engineer NSW DRE.

Monitoring of the “A” Line will provide information of relevance to each of the management plans listed in Section 7.1.
7.2.3 “B” Line

The location of the “B” Line is shown on Plan 7 in Attachment 1. The line is a longitudinal line approximately 300 m long, extending 100 m to the south-west and 200 m to the north east from the commencing end of Longwall 101.

The “B” Line will be composed of survey marks established at a spacing of approximately 15 m to 20 m. Survey marks will be comprised of either:

- concrete nails set in rock; or
- star pickets.

Due to the practicalities of following existing tracks and steep terrain, bends in the survey line may have to be incorporated.

Prior to installation of the survey marks, consideration will be given to the presence of Aboriginal heritage sites and if detected the survey marks will be located so as to avoid these heritage sites.

The purpose of the “B” Line is to measure the subsidence parameters (e.g. subsidence, tilt, strain) associated with extraction of Longwall 101.

The frequency of monitoring the “B” Line will be:

- prior to commencement of Longwall 101 extraction;
- at 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 101 commencing end;
- within three months following completion of Longwall 101; and
- more frequently if directed by the Principal Subsidence Engineer NSW DRE.

Monitoring of the “B” Line will provide information of relevance to each of the management plans listed in Section 7.1.

7.2.4 “C” Line

The location of the “C” Line is shown on Plan 7 in Attachment 1. The line is a longitudinal line approximately 450 m long, extending 150 m to the north-east and 300 m to the south-west of the finishing end of Longwall 101.
The “C” Line will be composed of survey marks established at a spacing of approximately 15 m to 20 m. Survey marks will be comprised of either:

- concrete nails set in rock; or
- star pickets.

Due to the practicalities of following existing tracks and steep terrain, bends in the survey line may have to be incorporated.

Prior to installation of the survey marks, consideration will be given to the presence of Aboriginal heritage sites and if detected the survey marks will be located so as to avoid these heritage sites.

The purpose of the “C” Line is to measure the subsidence parameters (e.g. subsidence, tilt, strain) associated with extraction of Longwall 101, particularly in the vicinity of the overlying tertiary sediments.

The frequency of monitoring the “C” Line will be:

- prior to secondary extraction within 400 m of the Longwall 101 take-off point;
- at 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 101 take-off point;
- within three months following completion of Longwall 101; and
- more frequently if directed by the Principal Subsidence Engineer NSW DRE.

Monitoring of the “C” Line will provide information of relevance to each of the management plans listed in Section 7.1.

### 7.2.5 “D” Line

The location of the “D” Line is shown on Plan 7 in Attachment 1. The line is a longitudinal line approximately 400 m long, extending 100 m to the north-east and 300 m to the south-west of the finishing end of Longwall 102. The line has been offset to the east from the centre of the panel to avoid interaction with the adjacent EEC.
The “D” Line will be composed of survey marks established at a spacing of approximately 15 m to 20 m. Survey marks will be comprised of either:

- concrete nails set in rock; or
- star pickets.

Due to the practicalities of following existing tracks and steep terrain, bends in the survey line may have to be incorporated.

Prior to installation of the survey marks, consideration will be given to the presence of Aboriginal heritage sites and if detected the survey marks will be located so as to avoid these heritage sites.

The purpose of the “D” Line is to measure the subsidence parameters (e.g. subsidence, tilt, strain) associated with extraction of Longwall 102, particularly in the vicinity of the overlying tertiary sediments.

The frequency of monitoring the “D” Line will be:

- prior to secondary extraction within 400 m of the Longwall 102 take-off point;
- at 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 102 take-off point;
- within three months following completion of Longwall 102; and
- more frequently if directed by the Principal Subsidence Engineer NSW DRE.

Monitoring of the “D” Line will provide information of relevance to each of the management plans listed in Section 7.1.

7.2.6 “E” Line

The location of the “E” Line is shown on Plan 7 in Attachment 1. The line is a longitudinal line approximately 400 m long, extending 100 m to the north-east and 300 m to the south-west of the finishing end of Longwall 103. The line has been offset to the east from the centre of the panel to avoid interaction with the adjacent EEC.
The “E” Line will be composed of survey marks established at a spacing of approximately 15 m to 20 m. Survey marks will be comprised of either:

- concrete nails set in rock; or
- star pickets.

Due to the practicalities of following existing tracks and steep terrain, bends in the survey line may have to be incorporated.

Prior to installation of the survey marks, consideration will be given to the presence of Aboriginal heritage sites and if detected the survey marks will be located so as to avoid these heritage sites.

The purpose of the “E” Line is to measure the subsidence parameters (e.g. subsidence, tilt, strain) associated with extraction of Longwall 103, particularly in the vicinity of the overlying tertiary sediments.

The frequency of monitoring the “E” Line will be:

- prior to secondary extraction within 400 m of the Longwall 103 take-off point;
- at 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the Longwall 103 take-off point;
- within three months following completion of Longwall 103; and
- more frequently if directed by the Principal Subsidence Engineer NSW DRE.

Monitoring of the “E” Line will provide information of relevance to each of the management plans listed in Section 7.1.

7.2.7 “BC” Line

The location of the “BC” Line is shown on Plan 7 in Attachment 1. The line is located across the top of the OC1 highwall/UG1 entries.

The “BC” line (i.e. OC1 highwall) will be scanned by the open cut surveyors.

The purpose of the “BC” Line is to measure the subsidence parameters (e.g. subsidence, tilt, strain) associated with extraction of each longwall panel and the total subsidence parameters associated with overall extraction.
The frequency of monitoring the “BC” Line will be:

- prior to commencement of Longwall 101 extraction;
- when the active longwall face is approximately 500 m from the Longwall 101 commencing end;
- when the active longwall face in Longwall 102 retreats past the Longwall 101 commencing end;
- when the active longwall face in Longwall 102 retreats approximately 500 m past the Longwall 101 commencing end; and
- more frequently if directed by the Principal Subsidence Engineer NSW DRE.

Monitoring of the “BC” Line will provide information of relevance for the management of MCO assets and highwall stability.

7.2.8 “FF” Line

The location of “FF” Line is shown on Plan 7 in Attachment 1. The “FF” Line follows the alignment of the Ulan-Wollar Road in the vicinity of Longwalls 101-103 and is constructed for the purpose of monitoring far field effects.

The “FF” Line will be composed of survey marks established at a spacing of approximately 15 m to 20 m, which will be comprised of either:

- concrete nails set in rock or bitumen; or
- star pickets.

Due to the practicalities of following the road, bends in the survey line will have to be incorporated.

The purpose of “FF” Line is to:

- provide monitoring of ground movements about the Ulan-Wollar Road (and adjacent telecommunication cables, Sandy Hollow Gulgong Railway and 330 kV ETL); and
- obtain subsidence information ahead of longwall panels to validate, and if necessary better calibrate, the MSEC subsidence prediction methods.

The frequency of monitoring “FF” Line will be:

- prior to commencement of Longwall 101 extraction;
- when mining reaches the “A” Line for Longwall 101;
prior to secondary extraction within 400 m of the Longwall 101 take-off point;

at 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the longwall take-off point;

within two weeks following completion of longwall recovery from each of Longwalls 101, 102 and 103;

within three months following completion of longwall recovery from each of Longwalls 101, 102 and 103;

at any time in case of fault or emergency and where requested by relevant asset owners; and

more frequently if directed by the Principal Subsidence Engineer NSW DRE.

The “FF” Line is a monitoring component of the LW101-103 BFMP-MWRC, LW101-103 BFMP-ARTC, LW101-103 BFMP-TELSTRA and LW101-103 BFMP-TRANSGRID.

7.2.9 Transmission Towers

The locations of the “Transmission Towers” monitoring are shown on Plan 7 in Attachment 1.

Monitoring for Longwalls 101-103 will include Transmission Towers 102 to 111 of TransGrid’s 330 kV ETL.

The “Transmission Towers” monitoring will be composed of:

- leg mounted survey marks (prisms) established at each of the four tower legs;
- target (bolt) locations on both earth peaks of each tower; and
- ground survey marks located at the base of each Transmission Tower (Towers 102 to 111).

Due to the practicalities of survey mark installation, prisms cannot be used at the tops of the towers.

The purpose of the “Transmission Towers” monitoring is to:

- provide monitoring of tower movements for the 330 kV transmission towers; and
- obtain subsidence information ahead of longwall panels to validate, and if necessary better calibrate the MSEC subsidence prediction methods.
The frequency of “Transmission Towers” monitoring will be:

- prior to commencement of Longwall 101 extraction;
- when mining reaches the “A” Line for Longwall 101;
- at 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the longwall take-off point;
- within two weeks following completion of longwall recovery from each of Longwalls 101, 102 and 103;
- within three months following completion of longwall recovery from each of Longwalls 101, 102 and 103;
- at any time in case of fault or emergency and where requested by TransGrid; and
- more frequently if directed by the asset owner or the Principal Subsidence Engineer NSW DRE.

The “Transmission Towers” monitoring is a component of the LW101-103 BFMP-TransGrid.

7.2.10 66 kV/22 kV Dual Circuit Powerline Poles

The location of the 66 kV/22 kV dual circuit powerline (supported on timber poles) is shown on Plan 7 in Attachment 1. Monitoring of timber poles within 300 m of Longwall 101, Longwall 102 and Longwall 103 will include two targets (an upper and lower survey mark) for measuring tilt.

The frequency of monitoring for potentially impacted poles within 300 m of the relevant longwall will be:

- prior to commencement of longwall extraction;
- prior to secondary extraction within 400 m of the longwall take-off point;
- at 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the longwall take-off point;
- within three months following completion of longwall recovery from each of Longwalls 101, 102 and 103; and
- more frequently if directed by the Principal Subsidence Engineer NSW DRE.

Monitoring of the 66 kV/22 kV dual circuit powerline poles is a component of the LW101-103 BFMP-EE.
7.2.11 Substation

The location of the proposed Essential Energy substation (in the Remote Services Facilities) is shown on Plan 7 in Attachment 1.

The substation monitoring will be composed of survey marks established at a spacing of approximately 15 m to 20 m around the substation. Survey marks will be comprised of either:

- concrete nails set in rock; or
- star pickets.

Due to the practicalities of following existing tracks and steep terrain, bends in the survey line may have to be incorporated.

Prior to installation of the survey marks, consideration will be given to the presence of Aboriginal heritage sites and if detected the survey marks will be located so as to avoid these heritage sites.

The purpose of the substation monitoring is to measure the subsidence parameters (e.g. subsidence, tilt, strain) around the Essential Energy substation.

The frequency of monitoring will be:

- prior to commencement of Longwall 101 extraction;
- prior to secondary extraction within 400 m of the Longwall 101 take-off point;
- at 100 m intervals determined by the longwall chainage marks while the active mining face is within 400 m of the longwall take-off point;
- within three months following completion of longwall recovery from each of Longwalls 101, 102 and 103; and
- more frequently if directed by the Principal Subsidence Engineer NSW DRE.

Monitoring of the substation is a component of the LW101-103 BFMP-EE.

7.2.12 Survey Station

The location of the “Murragamba Trig Station” Line is shown on Plan 7 in Attachment 1.
The frequency of monitoring the “Murragamba Trig Station” will be:

- prior to extraction of Longwall 101;
- within three months following completion of UG1; and
- more frequently if directed by the Principal Subsidence Engineer NSW DRE.

Monitoring of the “Murragamba Trig Station” will provide information of relevance for its re-establishment and/or replacement as necessary, on completion of subsidence.

### 7.2.13 Parameters to be Measured

Surveys will measure subsidence movements in three dimensions for the 330 kV transmission towers, 66 kV/22 kV dual circuit powerline poles and Ulan-Wollar Road. Surveys of railway and subsidence line marks will measure subsidence movements in two dimensions.

The OC1 highwall will be scanned.

### 7.2.14 Monitoring Methods and Accuracy

Longwall subsidence measurements will be surveyed in accordance with the relevant specifications and legislation as applied in NSW. These include:

- *Survey and Drafting Directions For Mine Surveyors 2015 (NSW – Mines)*; and
- *Inter-government Committee on Surveying and Mapping Standards and Practices for Control Surveys (SP1) Version 1.7 Sept 2007 ICSM Publication No.1 (ICSM SP1).*

The *Survey and Drafting Directions for Mine Surveyors 2015 (NSW – Mines)* Section 3.4 Correlation of Surface and Underground Surveys will be consistent with Class “D” survey as prescribed in ICSM SP1. It is intended that all Control Surveys for mine subsidence of the central areas of Longwalls 101-103 to be surveyed to Class “D” using prescribed methods as described in ICSM SP1.

### 7.3 SUBSIDENCE IMPACTS AND ENVIRONMENTAL CONSEQUENCES MONITORING COMPONENTS

The subsidence impact and environmental consequences monitoring components are summarised in Table 4. All subsidence impact and environmental consequence monitoring is included in a relevant management plan within the UG1 Longwalls 101-103 Extraction Plan as summarised in Table 4.
The subsidence impacts and environmental consequences monitored as part of each management plan are summarised in the following sections.

### 7.4 LONGWALLS 101 TO 103 LAND MANAGEMENT PLAN

The LW101-103 LMP has been prepared to manage the potential environmental consequences of the Longwalls 101-103 Extraction Plan on cliffs, minor cliffs and rock face features, steep slopes and land in general.

#### 7.4.1 Cliffs

Visual inspections of cliffs C5 and C6 will be conducted prior to commencement of secondary extraction of Longwalls 101 and 103, and following the completion of Longwall 103. Opportunistic observations of subsidence impacts to these cliffs will also be conducted during routine works by MCO and its contractors.

If additional subsidence impact(s) (i.e. cliff instabilities) are observed during an inspection, the following details will be noted and/or photographed:

- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- the location of the cliff instability (i.e. freshly exposed rock face and debris scattered around the base of the cliff) relative to the cliff face;
- the nature and extent of the cliff instability (including an estimate of volume);
- the length of the cliff instability;
- other relevant aspects such as water seepage (which can indicate weaknesses in the rock);
- whether any actions are required (e.g. implementation of management measures, initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety etc); and
- any other relevant information.

#### 7.4.2 Minor Cliffs, Rock Face Features, Steep Slopes and Land in General

A visual inspection of representative land features (i.e. minor cliffs, rock face features, steep slopes and land in general) within the Longwalls 101-103 Study Area will be conducted prior to the commencement of Longwall 101 to establish a baseline record.
Opportunistic observations of subsidence impacts to such land features will be conducted during routine works by MCO and its contractors. Where relevant, inspections of subsidence impacts will include detailed measurement and photographic record of the impact for comparison with baseline records.

If additional subsidence impact(s) are observed during an inspection, the total face area of any minor cliffs, rock face features and steep slopes that experience minor environmental consequences (i.e. rockfalls, displacement of or dislodgement of boulders or slabs, or fracturing) will be recorded.

7.5  LONGWALLS 101 TO 103 BIODIVERSITY MANAGEMENT PLAN

The LW101-103 BMP has been prepared to manage the potential environmental consequences of the Longwalls 101-103 Extraction Plan on aquatic and terrestrial flora and fauna.

7.5.1  Flora and Fauna Habitats

Longwall Panel Traverses

A series of transects will be established across the width of each longwall and have been indicatively positioned to intersect with the identified EECs. Each transect will be traversed to identify any subsidence related impacts. Key triggers to undertake more detailed monitoring include:

- areas of cracking or ponding that exceed predictions in the subsidence predictions and assessments of the impacts relating to the predicted subsidence above Longwalls 101-103;
- declining trend in canopy health or vegetation structure inconsistent with seasonal trends at analogue sites;
- deterioration in tree health outside natural variations (analogue sites to be used as a guide);
- areas of weed incursion and/or infestation; and
- mortality of more than a small number of threatened flora or fauna species attributed to subsidence impacts.

Opportunistic observations of subsidence impacts (e.g. surface cracking and ponding, deterioration of tree health and weed incursion and/or infestation) will be recorded during routine works conducted by MCO and its contractors. Where relevant, observations of subsidence impacts will include detailed measurement and photographic record of the impact for comparison with baseline records (Eco Logical, 2017).
Floristic Monitoring Sites

Nine floristic monitoring sites (i.e. total, not per transect) will be established at random locations along the longwall transects, with a minimum distance of 50 m between each site, and, where relevant, will be positioned proximal to any observed threatened species (e.g. Scant Pomaderris) and/or within the EECs (i.e. White Box, Yellow Box, Blakely’s Red Gum Grassy Woodland and Derived Native Grassland and Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions). Notwithstanding, in the event Scant Pomaderris is not identified along the longwall transects, visual monitoring of representative Scant Pomaderris individuals would be undertaken following completion of each longwall. Each site will be marked with a metal star picket (Eco Logical, 2017).

Data collected at each floristic monitoring site will include:

- Canopy health and defoliation (all in 5% increments):
  - percentage of epicormic foliage in relation to total tree foliage;
  - proportion of primary branches within canopy that have died back;
  - percentage of current canopy foliage as a proportion of the estimated canopy foliage volume/potential canopy; and
  - percentage of canopy foliage discoloured.

- Vegetation structure:
  - projected foliage cover (PFC) (PFC – 1 to 5%, then 5% increments) of native grass/ground cover;
  - native shrubs <1 m height, native shrubs/small trees >1 m height;
  - PFC 5% increments of upper canopy (assessed at each quadrat corner and averaged);
  - exotic species;
  - number of stags, estimated time since cause of death;
  - lower, estimated median and upper height of canopy (m);
  - lower, estimated median and upper diameter at breast height (DBH) over bark of canopy stems (centimetres);
  - abundance of each canopy species (identified to species level); and
  - calculated, total stems per hectare (ha).

- Photograph of the canopy (camera placed on top of the star picket, facing up); photograph facing due north, south, east and west from the star picket.
In the event monitoring identifies subsidence related impacts to threatened flora, fauna or EECs, MCO will investigate the implementation of additional monitoring or appropriate management measures. Potential subsidence related impacts include:

- areas of cracking or ponding that exceed predictions in the subsidence predictions and assessments of the impacts relating to the predicted subsidence above Longwalls 101-103;
- declining trend in canopy health or vegetation structure inconsistent with seasonal trends at analogue sites;
- deterioration in tree health outside natural variations (analogue sites to be used as a guide);
- areas of weed incursion and/or infestation; or
- mortality of more than a small number of threatened flora or fauna species attributed to subsidence impacts.

**Terrestrial Fauna and their Habitats**

The terrestrial fauna and habitat monitoring will be based on a review of the results of the flora/vegetation monitoring to determine any potential impacts on fauna habitats. Opportunistic recording of fauna species will also be undertaken during the traverses of the longwall transects (Eco Logical, 2017).

Terrestrial fauna monitoring will be used to assess the environmental consequences of subsidence impacts, including the nature and extent of impacts on flora and fauna habitats and evidence of impacts on terrestrial fauna.

Review of the cliff line monitoring data will be undertaken, particularly in relation to any potential roosting sites for cave-dwelling bats (including the Large-eared Pied Bat). In the event that impacts are considered likely to occur, or are identified as having occurred, inspection of any potential roosting sites for the Large-eared Pied Bat will be undertaken to document any potential impacts.

### 7.6 LONGWALLS 101 TO 103 WATER MANAGEMENT PLAN

The LW101-103 WMP has been prepared to manage the potential environmental consequences of the Longwalls 101-103 Extraction Plan on water resources (including drainage lines and groundwater aquifers).
7.6.1 Drainage Line (DL7)

Visual inspections and photographic records of drainage line DL7 will be conducted prior to and following undermining. This would be undertaken by walking the length of drainage line DL7 over Longwall 103 and noting any areas of active erosion, sediment deposition, water ponding or streambed cracking.

An inspection would be conducted every six months for one year after a longwall undermines drainage line DL7 to identify any evidence of subsidence impacts compared to baseline records.

7.6.2 Surface Water

Surface water monitoring for receiving watercourses is undertaken for flow, water quality, stream health and channel stability as described in the approved complex-wide Surface Water Management Plan.

Water quality sampling of receiving streams will continue to be undertaken in accordance with the approved complex-wide Surface Water Management Plan. Appropriate water quality monitoring locations are downstream of DL7, on Murragamba Creek (SW04) and Wilpinjong Creek (SW16).

7.6.3 Groundwater

Groundwater monitoring is undertaken for groundwater extraction, groundwater levels, groundwater quality and leachate/seepage losses from water and water storages as described in section 6.0 of the approved complex-wide Groundwater Management Plan. Groundwater monitoring bores considered by HydroSimulations (2017) to be relevant to Longwalls 101-103 are detailed in the LW101-103 WMP.

7.6.4 Palaeochannel Monitoring Bore

An additional palaeochannel monitoring bore (standpipe) have been established to the north-east of Longwall 101 to monitor groundwater levels in the palaeochannel, as recommended by HydroSimulations (2017).

The new monitoring bore was installed approximately three months prior to the commencement of longwall mining in Longwall 101.
7.6.5 Mine Water Make

Monitoring of the mine water make will comprise:

- Metered water reticulated into the mine (recorded continuously and downloaded weekly).
- Metered water reticulated out of the mine (recorded continuously and downloaded weekly).

The inferred water make (i.e. groundwater that has seeped into the mine through the strata) will be calculated from the difference between total mine inflows (reticulated water into the mine) and total mine outflows (reticulated water out of the mine). If determined to be of significance, differences in moisture content of ventilation air (downcast and exhaust) and coal (in-situ and ROM) will also be considered.

Given the anticipated fluctuations in daily water usage and the cycle period for water entering the mine, being used by machinery, and draining to sumps for return pumping to the surface, a 14 day average will be used to provide a more reliable estimate of water make.

7.7 LONGWALLS 101 TO 103 HERITAGE MANAGEMENT PLAN

The LW101-103 HMP has been prepared to manage the potential environmental consequences of the Longwalls 101-103 Extraction Plan on Aboriginal and historic heritage.

7.7.1 Aboriginal Heritage Site (PAD 3 Moolarben Coal)

MCO will undertake subsidence monitoring of site PAD 3 Moolarben Coal. In order to identify and document whether any subsidence impacts have arisen from mining activities at PAD 3 Moolarben Coal, the monitoring requirements described in the approved complex-wide Heritage Management Plan will be implemented for this site. Monitoring will involve the following:

- **MCO will engage an appropriately qualified expert to monitor the Aboriginal archaeological sites described as requiring monitoring. This may include the establishment of a percentage estimate of the likelihood of subsidence occurring in sensitive areas.**

- **Where insufficient pre-existing information is available for any of the specific Aboriginal archaeological sites to permit comparison with the condition post-mining, more detailed recording will occur prior to undermining.**
- Monitoring will involve inspecting and recording the condition of these specific Aboriginal archaeological sites within three to six months after undermining has occurred. Each inspection will involve recording data on environmental conditions, pre-existing human and natural impacts, heritage evidence present and any identified changes to these environmental and heritage conditions compared with previous inspections. The potential cause (subsidence or other impacts) of changes to the condition of individual sites will be assessed.

- Monitoring will be focused on the features of the site that make it significant (e.g. grooves, art, artefacts and/or PAD).

- A report documenting the results of monitoring will be prepared that details the methodology of the inspections, conditions of the environment and Aboriginal heritage evidence at the relevant sites, comparisons with previously reported conditions at each site, identification of any natural and/or human impacts during the intervening period, identification of any implications for the ongoing management and protection of Aboriginal heritage evidence at the Moolarben Coal Complex, and documentation of the actual impacts of operations on the Aboriginal archaeological sites.

- Copies of this report will be distributed to the RAPs, OEH and the DP&E and a summary included in the Annual Review.

Monitoring for subsidence related impacts will occur at PAD 3 Moolarben Coal within three to six months of undermining. If, during the above monitoring, significant subsidence impacts are identified, then the salvage and excavation procedures outlined in the LW101-103 HMP and complex-wide HMP will be considered.

Monitoring and/or salvage and/or excavation would only occur where safe to do so, as determined in consultation with relevant MCO safety personnel.

For the purpose of determining what constitutes a significant subsidence impact on Aboriginal heritage sites, a site is considered to be “affected by significant subsidence impacts” if it exhibits one or more of the following consequences that cannot be attributed to natural weathering or deterioration:

- overhang collapse;
- cracking of sandstone that coincides with the feature(s) of the site that make it significant; and
- rock fall that damages the feature(s) of the site that make it significant.
7.8 LONGWALLS 101 TO 103 BUILT FEATURES MANAGEMENT PLANS

A number of component plans have been prepared to manage the potential environmental consequences of the Longwalls 101-103 Extraction Plan on built features including:

- 66 kV/22 kV dual circuit powerline on timber poles and Essential Energy substation (LW101-103 BFMP-EE).
- 330 kV ETL and towers (LW101-103 BFMP-TRANSGRID).
- Ulan-Wollar Road (LW101-103 BFMP-MWRC).
- Telecommunication (optical fibre and copper) cables (LW101-103 BFMP-TELSTRA).
- Sandy Hollow Gulgong Railway (LW101-103 BFMP-ARTC).

Each of the Longwalls 101 to 103 Built Features Management Plans has been developed in consultation with the relevant asset owner in accordance with Condition 5(g), Schedule 4 of Project Approval (08_0135).

Any subsidence impacts will be recorded in the relevant Built Features Management Plan – Subsidence Impact Register.

7.8.1 66 kV/22 kV Dual Circuit Powerline Poles (LW101-103 BFMP-EE)

A visual inspection (including structural assessment) of the 66 kV/22 kV dual circuit powerline will be conducted prior to secondary extraction within 400 m of the Longwall 101 take-off positions. Visual inspections will also be conducted by MCO at the 66 kV/22 kV dual circuit powerline in the event monitoring detects movements in excess of survey/design tolerances. Additional opportunistic observations of subsidence impacts will be conducted during routine works by MCO and its contractors.

As described in Section 7.2.7, monitoring for the timber poles will include two targets (an upper and lower survey mark) for measuring tilt.

Where relevant, inspections of subsidence impacts will include photographic record of the impacts from nominated photo points for comparison with baseline photographic records.

Unless otherwise agreed with Essential Energy, inspection sheets detailing the outcome of the subsidence impact monitoring program will be provided to Essential Energy.
It is understood that Essential Energy also conducts routine inspections (including fault and emergency patrols) which would be used for monitoring of the impacts of subsidence if conducted during the course of mining Longwalls 101-103.

7.8.2 Essential Energy Substation (LW101-103 BFMP-EE)

The substation foundation will be designed in consultation with Essential Energy.

A visual inspection of the Essential Energy substation will be conducted prior to secondary extraction within 400 m of the Longwall 101 take-off positions. Visual inspections will also be conducted by MCO at the substation in the event monitoring detects movements in excess of survey/design tolerances. Additional opportunistic observations of subsidence impacts will be conducted during routine works by MCO and its contractors.

Where relevant, inspections of subsidence impacts will include photographic record of the impacts from nominated photo points for comparison with baseline photographic records.

Unless otherwise agreed with Essential Energy, inspection sheets detailing the outcome of the subsidence impact monitoring program will be provided to Essential Energy.

7.8.3 330 kV ETL Towers (LW101-103 BFMP-TRANSGRID)

A visual inspection/baseline audit of the 330 kV ETL will be conducted prior to commencement of Longwall 101 unless TransGrid has completed, or will complete, a suitable inspection prior to commencement of Longwall 101. Where relevant, inspections of subsidence impacts will include photographic record of the impacts from nominated photo points for comparison with baseline photographic records.

As described in Section 7.2.6, monitoring will include Transmission Towers 102 to 111 of TransGrid’s 330 kV ETL.

Surveys of Towers 102 to 111 will be conducted prior to extraction of Longwall 101, when mining reaches the mid-point of Longwall 101, and at 100 m intervals based on longwall chainage marks when mining is within 400 m of the longwall take-off position (e.g. at a frequency of approximately one to two weeks based on expected longwall progression). Surveys will also be conducted following completion of longwall recovery (the first within two weeks and the second within three months). Additional opportunistic observations of subsidence impacts will be conducted during routine works by MCO and its contractors. Surveys of Towers 102 to 111 will include measurement of differential separation between tower legs and monitoring of both earth peaks.
Inspection sheets detailing the outcomes of the subsidence impact monitoring program will be provided to TransGrid during mining of Longwall 101 (requirement to be reviewed following completion of Longwall 101).

It is understood that TransGrid also conducts routine inspections (including fault and emergency patrols) which would be used for monitoring of the impacts of subsidence if conducted during the course of mining Longwalls 101-103.

7.8.4 Ulan-Wollar Road (LW101-103 BFMP-MWRC)

A visual inspection of Ulan-Wollar Road will be conducted prior to commencement of Longwall 101 to establish the condition of the roadway and pipes/culverts.

The visual inspection will be conducted by MCO and include:

- recording of existing defects using detailed road surface photography (video), i.e. one photograph every 2 m; and
- recording of existing pipe/culvert condition.

A copy of the visual inspection report will be provided to MWRC. Other road pavement baseline records (where available) would be provided to MCO.

In the event monitoring identifies ground movement (in excess of survey accuracy) MCO will undertake an inspection of the road for any impacts caused by subsidence movements. Opportunistic observations of subsidence impacts will be conducted during routine works by MCO (and its contractors) and MWRC’s routine road condition inspections.

As described in Section 7.2.5, monitoring will include the “FF Line” which follows the alignment of the Ulan-Wollar Road.

Unless otherwise agreed with MWRC, inspection sheets detailing the outcome of the subsidence impact monitoring program will be provided to MWRC following confirmation of the results.

7.8.5 Telecommunication (Optical Fibre and Copper) Cables (LW101-103 BFMP-TELSTRA)

Prior to the commencement of Longwall 101 extraction, in conjunction with Telstra, MCO will conduct an investigation to determine the Telstra customers that would be affected if the copper cabling became unserviceable and what service would need to be provided while copper cabling repairs were carried out.
An inspection of the physical location of the telecommunication cables within 400 m of Longwalls 101-103 will also be conducted prior to commencement of Longwall 101 to confirm access.

A baseline resistance test (of the copper cable) and RFMS measurement (of the optical fibre cable) will be completed prior to secondary extraction occurring within 400 m of the Longwall 101 take-off position. Additional resistance tests of the copper cable will be undertaken in the event monitoring of the FF Line identifies ground movements in excess of survey accuracy. RFMS monitoring will occur continuously while mining is within 400 m of the optical fibre cable.

In the event that resistance tests detect a significant variation from the baseline reading, or, in the event RFMS detects a change from the baseline condition that exceeds ± 3.0 dB, Telstra will conduct a subsidence impact inspection targeting the identification of movement of the cable and ground compression/tension.

Visual inspections of the cables will be conducted by Telstra as required, in accordance with Telstra’s routine inspection program or if triggered by a signal loss or transmission fault detected by the RFMS.

Unless otherwise agreed with Telstra, inspection sheets detailing the outcome of the subsidence impact inspections will be provided, following confirmation of any observed ground movements.

7.8.6 Sandy Hollow Gulgong Railway (LW101-103 BFMP-ARTC)

A baseline inspection (including visual inspection and dilapidation audit) of the Sandy Hollow Gulgong Railway in the vicinity of Longwalls 101-103 will be conducted prior to mining within 400 m of the Longwall 101 take-off position.

A survey along the FF Line will be undertaken prior to secondary extraction within 400 m of the Longwall 101 take-off point. Additional surveys along the FF Line will be undertaken by MCO while mining is within 400 m of the longwall take-off position (i.e. at 100 m intervals as determined by the longwall chainage marks).

As described in Section 5.2.1, monitoring will include the Railway Line which follows the alignment of the Sandy Hollow to Gulgong Railway in the vicinity of Longwalls 101-103. In the event monitoring identifies ground movement (in excess of survey accuracy) MCO will undertake an inspection of the Railway Line for any impacts caused by subsidence movements. Opportunistic observations of subsidence impacts will be conducted during routine works by MCO and its contractors.
As agreed with ARTC, in the event the subsidence monitoring program identifies ground movements (in excess of survey accuracy), inspection sheets detailing the results of the subsidence monitoring program will be provided to ARTC, following confirmation of the results.

It is understood that ARTC also conducts routine inspections (including fault and emergency patrols) which would be used for monitoring of the impacts of subsidence if conducted during the course of mining Longwalls 101-103.

7.9 FENCES, SURFACE DAM AND ACCESS ROADS/TRACKS

Visual inspections of fences, access roads/tracks and the surface will be conducted opportunistically by MCO.

7.10 MINE INFRASTRUCTURE

Visual inspections of mine infrastructure (e.g. conveyor, haul road, out-of-pit emplacement, open cut highwalls, etc.) will be conducted through routine (e.g. each shift) statutory inspections with additional inspection frequencies as determined by the Subsidence Principal Hazard Management Plan.

7.11 SURVEY CONTROL MARKS

As described in Section 7.2.9, monitoring of the “Murragamba Trig Station” will be conducted to provide information of relevance for its re-establishment and/or replacement as necessary, on completion of subsidence.
8.0 ANALYSIS OF SUBSIDENCE EFFECTS, SUBSIDENCE IMPACTS AND ENVIRONMENTAL CONSEQUENCES

Analysis of the relationship between subsidence effects, subsidence impacts and environmental consequences will be reported annually in the Annual Review. The analysis will include:

- comparison of predicted subsidence effects and measured parameters;
- comparison of predicted subsidence impacts and measured impacts;
- analysis of any variations between predicted and measured conventional subsidence effects and impacts (e.g. consideration of underlying parameters such as distance functions, etc. used to determine the predicted subsidence profile);
- analysis of variations between predicted and measured far-field movements and non-conventional subsidence effects (e.g. effects of geological structures and valley closure) and impacts; and
- analysis of the 3D movement about longwall extraction with particular reference to the transverse and longitudinal movements versus distance in advance of the longwall panel.

The analyses will be used to assess the validity of the subsidence predictions and to refine the predictive methods where appropriate.

The relationship between subsidence effects, impacts and environmental consequences will be determined through review and reporting of each component management plan (e.g. LW101-103 LMP, LW101-103 WMP, LW101-103 BMP, LW101-103 HMP and LW101-103 BFMPs).
9.0 ROLES AND RESPONSIBILITIES

Key responsibilities of MCO personnel in relation to this LW101-103 SMP are summarised in Table 5. Responsibilities may be delegated as required.

Table 5: Longwalls 101 to 103 Subsidence Monitoring Program Responsibility Summary

<table>
<thead>
<tr>
<th>Responsibility</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Manager</td>
<td>• Ensure resources are available to MCO personnel to facilitate the completion of responsibilities under this LW101-103 SMP.</td>
</tr>
<tr>
<td>Underground Technical Manager</td>
<td>• Ensure the LW101-103 SMP is implemented.</td>
</tr>
<tr>
<td></td>
<td>• Ensure monitoring required under this LW101-103 SMP is carried out within specified timeframes, adequately checked and processed and prepared to the required standard.</td>
</tr>
<tr>
<td></td>
<td>• Undertake relevant monitoring summarised in Section 7.</td>
</tr>
<tr>
<td>Environmental and Community Manager</td>
<td>• Ensure the LW101-103 SMP is implemented.</td>
</tr>
<tr>
<td></td>
<td>• Liaise with relevant stakeholders regarding subsidence impact management and related environmental consequences.</td>
</tr>
<tr>
<td>Registered Mine Surveyor</td>
<td>• Undertake all subsidence monitoring to the required standard within the specified timeframes and ensure data are adequately checked, processed and recorded.</td>
</tr>
</tbody>
</table>

9.1 KEY CONTACTS

The details of key contacts and phone numbers in relation to this LW101-103 SMP are summarised in Table 6.

Table 6: Longwalls 101 to 103 Subsidence Monitoring Program Key Personnel Contact Details

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Position</th>
<th>Contact Name</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCO</td>
<td>Underground Technical Manager</td>
<td>Mr Adrian Moodie</td>
<td>02 6376 1604</td>
</tr>
<tr>
<td></td>
<td>Environmental and Community Manager</td>
<td>Mr Graham Chase</td>
<td>02 6376 1407</td>
</tr>
<tr>
<td></td>
<td>Registered Mine Surveyor</td>
<td>Mr Zac Burley</td>
<td>02 6376 1613</td>
</tr>
<tr>
<td></td>
<td>Moolarben Coal Hotline</td>
<td></td>
<td>1800 556 484</td>
</tr>
<tr>
<td>DRE</td>
<td>Principal Subsidence Engineer</td>
<td>Dr Gang Li</td>
<td>02 4931 6644</td>
</tr>
</tbody>
</table>
10.0 REFERENCES

Department of Planning & Environment and Division of Resources and Energy (2015) *Guidelines for the Preparation of Extraction Plans*.

Eco Logical Australia Pty Ltd (2016) *Moolarben Coal UG1 Vegetation Validation*.


ATTACHMENT 1

PLANS 1 TO 7
(IN ACCORDANCE WITH THE DEPARTMENT OF PLANNING AND ENVIRONMENT AND DIVISION OF RESOURCES AND ENERGY [2015] GUIDELINES FOR THE PREPARATION OF EXTRACTION PLANS)